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The Aerovox Research Worker

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The Construction and Operation of a Simple Capacity Test Meter

By the Engineering Department, Aerovox Corporation

A NUMBER of readers have written us regarding the construction of test apparatus that will be useful in service work and experimentation to test the capacity of condensers. A number of such units have been described in past issues of the Research Worker but they have been concerned generally with the measurement of the capacity of electrolytic condensers and the recent correspondence on the subject has been more with relation to the testing of paper condensers. The unit to be described is useful for testing condensers over a range from .002 to 2.5 mfds. and can be used to test all types of electrostatic condensers that are within the above limits of capacity. In other words the meter will test for capacity practically every paper condenser used in the present day radio receiver and will also test some of the mica condensers to be found in such sets. This test unit cannot be used to test electrolytic condensers because the voltage is too great. The same instrument recommended for use here can however be applied to the test unit described in the January, 1934 issue of the Research Worker to make up an instrument which can also be used for testing the capacity of dry electrolytic condensers.

The theory of this capacity test unit is the simple one of applying a known voltage to a condenser and measuring the amount of current that flows through the condenser. From the readings of current and voltage the capacity can be calculated, but to simplify the matter there is given on page 3 a chart which makes it possible to read off the capacity from the chart after the necessary voltage adjustment has been made and the current read on the meter. By resorting to somewhat more complicated calibration methods than are given herein more rapid testing is possible but the additional calibration difficultes involved are hardly warranted in view of the fact that the number of condensers which must be checked for capacity by the average service shop or experimenter are not sufficiently great as to necessitate very rapid testing. If the chart given on page 3 is cut out and mounted alongside the tester we are sure that most readers will find the device altogether satisfactory.

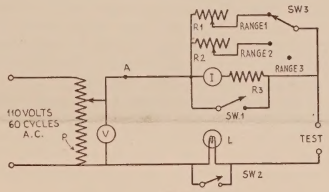

FIG. 1

The fundamental circuit of the meter is given in Fig. 1. The source of voltage is the 110 volt 60 cycle a. c. line. Across the line is connected a potentiometer P which serves to permit adjustment of the voltage to the proper value. Theoretically, this potentiometer should be of the continuously variable type, but from the standpoint of simplicity it can be an adjustable unit, and the calibration chart has been based on the use of such a resistor. The meter I is a 1 milliampere full scale rectifier type a. c. milliammeter. The resistors R_1 and R_2 are adjustable type resistors, and R_3 is a fixed resistor. These parts together with the switches required are listed below:

P Adjustable Resistor, Aerovox Type 956, 200 ohm Adjustable Pyrohm Resistor.

I Rectifier type a. c. milliammeter. Range—1 ma full-scale.

R_1 Adjustable Resistor, Aerovox Type 950, 100 ohm Adjustable Pyrohm Resistor.

R_2 Adjustable Resistor, Aerovox Type 950, 750 ohm Adjustable Pyrohm Resistor.

R_3 Fixed Resistor, 2,000 ohms, Aerovox Type 931.

L Ordinary low watt electric lamp.

Sw_1, Sw_2 Single pole single throw button type switches.

Sw_3 Three point contact switch.

V 100 volt a. c. voltmeter.

The various parts can be laid out in any convenient manner. If a panel is used, the only parts that need be on the panel are the meters and the three switches. The lamp L is a short indicator and while it can be mounted in the rear some arrangement should be made so that the light from it is visable to the operator.

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After the units are mounted in place the calibration of the various ranges must be carried out. All this really involves is adjustment of the two resistors R_1 and R_2 to the proper values. This can conveniently be done as follows:

Temporarily connect the meter as shown in Fig. 2 to a small filament transformer, 6 to 10 volts, across the secondary of which is placed a low resistance potentiometer R. Switch Sw_1 should be open and switch Sw_2 should be closed. The switch Sw_3 should be placed on the contact corresponding to "Range 2" which is the position to which the 750 ohm resistor is connected across the meter. In series with the capacity meter itself connect a 10 milliampere a. c. milliammeter at the point marked A in Fig. 1; this meter is shown as A in Fig. 2. The two terminals marked "Test" should be shorted.

Now move the arm of the potentiometer R to the end marked 2 in the diagram Fig. 2. In this position no voltage will be applied to the capacity test meter when the transformer is connected to the power line. This point is very important because a mistake may burn out the low range milliammeter.

Now connect the transformer to the 110 volt line and very gradually move the arm of the potentiometer R at the same time watching the two meters. The job now is to adjust resistor R_2 to such a position that the meter I will read full scale when the other a. c. milliammeter A reads 10 milliamperes. This is best done step by step. If the meter A reads 10 milliamperes before the meter I reads full scale then the resistance of R_2 must be increased; if the meter A reads less than 10 milliamperes when the meter I reads full scale then the resistance of R_2 must be decreased. The best method is to read the two meters, decide what adjustment must be made, then bring the slider of the potentiometer R to the zero voltage position before the actual adjustment in R_2 is attempted. When the resistance of R_2 has been made such that the meter I reads full scale when the meter A reads 10 milliamperes the calibration of the "Range 2" is completed. It is now necessary to calibrate "Range 3."

This is done in the same manner as described above. The only change necessary is that the meter A must be replaced with one which will read 100 milliamperes a. c. The problem here is to so adjust R_3 that the meter I will read full scale when the meter A reads 100 milliamperes. When this has been accomplished the calibration of the unit is complete and the meter is ready for use.

It should be realized that the accuracy obtained from the instrument will depend greatly upon the care with which the above adjustments of R_1 and R_2 are carried out. Furthermore when the proper adjustments have been found means should be taken to prevent any change in the adjustment. If the slider type resistors are used the clamping nuts should be well tightened in place.

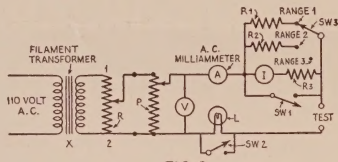


FIG. 2

The unit can now be restored to its original condition as shown in Fig. 1 and when this is done it is ready for use. After the unit has been connected to the 110 volt line the slider on the resistor P should be adjusted to the point where the voltmeter V reads 100 volts. The voltmeter should read 100 volts at all times. If the voltmeter does not read 100 volts the capacity reading will be somewhat inaccurate but ordinarily a few volts more or less than 100 will not be found to be of importance especially in view of the fact that the condensers themselves are made generally to tolerances in the order of plus or minus 10 per cent or even more. Since the condensers may be 10 per cent higher or lower than their rated value a few per cent inaccuracy in the meter reading is not of prime importance. If the line voltage fluctuations are considerable it may be necessary to use a regular adjustable potentiometer at P.

To test a condenser the procedure is as follows:

1 Connect the range switch to "Range 1."
2 Close switch Sw_1
3 Open switch Sw_2
4 Connect the condenser to be tested across the two test terminals.

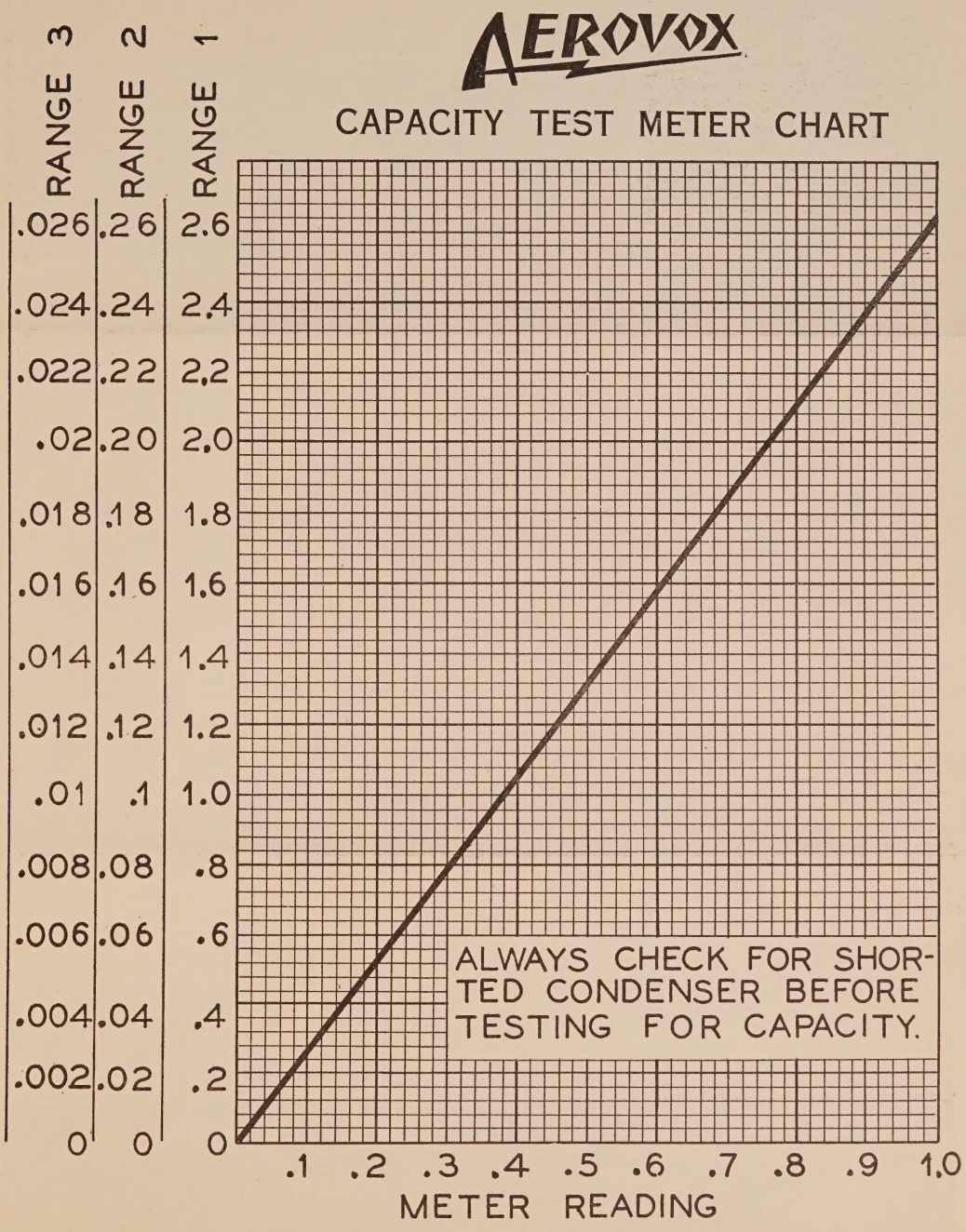
If the lamp L immediately lights, the condenser is shorted and no further tests should be made. If the lamp does not light then the condenser is not shortetd and it can be tested for capacity. This is done by closing switch Sw_2 and then opening switch Sw_1. If the meter reads more than 0.1 mA the reading should be noted and the corresponding capacity determined from the chart. If the meter reads less than 0.1 then the range switch Sw_3 should be moved to "Range 2" and the meter read. If however the reading is still too small to obtain a good reading the "Range 3" can be used. In any event the capacity is always determined by reading from the chart the capacity in mfds. corresponding to the meter deflection and the range used.

For example suppose that a condenser was being tested and it gave a reading of 0.5 mA on "Range 2." Then from the chart page 3 the capacity of the condenser must be 0.131 mfd. If on the other hand the reading was 0.8 mA on "Range 1" then the capacity would be 2.1 mfd.

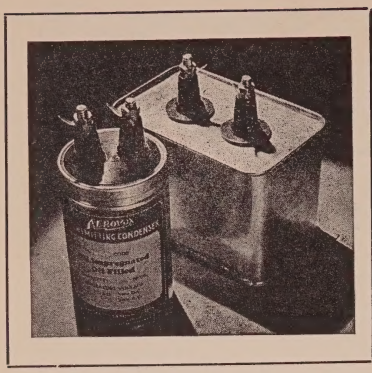
The instrument can be made somewhat more foolproof and simpler in operation if the switches Sw_1 and Sw_2 are both combined into a single switch of the momentary contact type. In this type of switch the normal position would be such that Sw_2 would be open and Sw_1 would be closed. Then if the condenser has been placed across the test terminals and the lamp does not light the switch button can be pressed which will cause the switch across L to close and the short circuit switch across the meter to open. In this manner it would be impossible for the operator to leave switch Sw_1 open which would result in a burned out meter if a shorted condenser was placed across the test terminals with the switch Sw_1 in the open position.

The type of capacity test meter described in this issue differs from other types of test meters in that essentially uniform scales are obtained which is not the case in ordinary types of instruments which use a resistance in series with the circuit to prevent meter damage—an advantage from this standpoint but a disadvantaage from the standpoint of scale uniformity.

This instrument is not presented as one designed for the accurate measurement of condenser capacity but rather as a means to permit the determination of condenser capacity within what are in most cases commercial tolerances. The errors involved are too large—the rectifier type meter alone may have an error at full scale deflection in the order of five per cent—for accurate work, but in most cases, service work requires the determination of what we might call the nominal capacity and the meter should prove effective for this purpose.



The above chart can be cut out and mounted either directly on the inside cover of a case provided for the unit, or on cardboard for use in conjunction with the meter described in the accompanying article.



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2	1 1/2 x 3 1/8 x 4 7/8	5.75	2	4 3/4 x 3 1/8 x 4 7/8	17.00
4	2 1/8 x 3 1/8 x 4 7/8	8.50	4	7 5/8 x 3 1/8 x 4 7/8	25.00
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2	2 1/4 x 3 1/8 x 4 7/8	8.25	2	7 1/4 x 3 1/8 x 4 7/8	25.50
4	3 3/4 x 3 1/8 x 4 7/8	12.00	4	12 3/4 x 3 1/8 x 4 7/8	39.25
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2	4 x 3 1/8 x 4 7/8	12.25	1	5 3/4 x 3 1/8 x 4 7/8	24.00
4	6 1/4 x 3 1/8 x 4 7/8	16.50	2	9 7/8 x 3 1/8 x 4 7/8	30.00
			Type 5006-5000v		
			.5	4 3/4 x 3 1/8 x 4 7/8	$22.50
			1	7 7/8 x 3 1/8 x 4 7/8	28.50

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